

## PATENT APPLICATION TRANSMITTAL LETTER

## ASSISTANT COMMISSIONER FOR PATENTS:

Transmitted herewith for filing under 35 U.S.C. 111 and 37 CFR 1.53 is the patent application of

Louis F. Aprigliano and Leslie K. Kohlerentitled METHOD OF PRODUCING CORROSION RESISTANT METAL ALLOYS WITH IMPROVED STRENGTH AND DUCTILITY

Enclosed are:

☒ 4 pages of specification☒ 1 pages of claims☒ 1 sheets of drawing☐ formal ☒ informal☐ an assignment of the invention to \_\_\_\_\_☒ executed Oath or Declaration of the inventors.☐ a certified copy of a \_\_\_\_\_ application.☐ associate power of attorney.☒ information disclosure statement☒ Form PTO-1449(PTO/SB/O8A and O8B)☐ preliminary amendment☐ other: \_\_\_\_\_

## CLAIMS AS FILE

	Number Filed	Number Extra	Rate	Fee
BASIC FEE (37 CFR 1.16(a))			\$690	\$690.00
TOTAL CLAIMS (37 CFR 1.16(c))	4 - 20=	* 0	x \$18	
INDEPENDENT CLAIMS (37 CFR 1.16(b))	3 - 3 =	* 1	x \$ 78	
MULTIPLE DEPENDENT CLAIM PRESENT	37 CFR 1.16(d))		\$270	
*Number extra must be zero or larger	TOTAL			\$690.00
If applicant has small entity status under 37 CFR 1.9 and 1.27 then divide total fee by 2 and enter amount here			SMALL ENTITY	\$

☐ A check in the amount of \$ \_\_\_\_\_ to cover the filing fee is enclosed.☒ The Commissioner is hereby authorized to charge and credit Deposit Account No. 50-0958 as described below. I have enclosed a duplicate copy of this sheet.☒ Charge the amount of \$ 690.00 as filing fee.☒ Credit any overpayment.☒ Charge any additional filing fees required under 37 CFR 1.16 and 1.17.☐ Charge the issue fee set in 37 CFR 1.18 at the mailing of the Notice of Allowance, pursuant to 37 CFR 1.31(b)

Date

9/6/2000

Jacob Shuster  
 Jacob Shuster, Reg. No. 19,660  
 Office of Counsel Code 004  
 Naval Surface Warfare Center  
 Carderock Division Headquarters  
 David Taylor Model Basin  
 9500 MacArthur Boulevard  
 West Bethesda, MD 20817-5700

09/07/00  
 1:658 U.S. PTO

JC918 U.S. PTO  
 09/656017  
 09/07/00

1 Navy Case No. 82,627

2 **METHOD OF PRODUCING CORROSION RESISTANT METAL**  
3 **ALLOYS WITH IMPROVED STRENGTH AND DUCTILITY**

4 The present invention relates generally to the formation of a metal alloy having desirable  
5 properties in addition to ductility, despite the presence of a high content of chromium therein and  
6 is a continuation-in-part of the disclosure in prior copending application Serial No. 09/233,907,  
7 filed January 21, 1999.  
8

9 BACKGROUND OF THE INVENTION

10 Nickel-chromium alloys with chromium contents of 40% by weight or more have  
11 extremely low ductility. An improvement in both strength and ductility by casting of such high  
12 chromium content alloys was totally unexpected.

13 The use of spray casting in the formation of metal alloys having a low chromium content  
14 is generally well known. Such process involves the use of an atomizing gas to which the molten  
15 alloy is exposed as disclosed for example in U.S. Patent Nos. 4,117,209, 4,606,948, 4,977,950,  
16 5,017,250, 5,154,219, 5,489,417 and Re31,767, respectively issued to Markin et al., Hajmrle et  
17 al., Muench, Ashok, Watson et al., (2), and Brooks. U.S. Patent No. 4,779,802 to Coombs is of  
18 interest in regard to spray forming atomization. Only the foregoing referred to Markin et al. and  
19 Hajmrle patents also relate to use of the spray casting process for nickel-chromium types of  
20 alloys, expressly limited to low content chromium of 20% by weight or less. The production of  
21 Nickel-chromium alloy is also disclosed in U.S. Patent No. 5,843,587 to Nakamori for use as a  
22 gas turbine blade coating without regard to increasing alloy strength. The spray casting process  
23 was not heretofore expected to produce a metallic nickel type of alloy having the advantage of  
24 high ductility in connection with a high chromium content in excess of 40% by weight.  
25  
26  
27  
28

1 It is therefore an important object of the present invention to provide a method for  
2 producing a metallic alloy with a high chromium content, having an increase in both strength and  
3 ductility despite the normally expected presence of brittleness associated with high chromium  
4 content alloys.  
5

#### 6 SUMMARY OF THE INVENTION

7 In accordance with the present invention, a spray metal forming process is utilized to  
8 produce an alloy, wherein the alloy components are melted and mixed under cover of an inert gas  
9 and allowed to form a molten metal outflow stream that is atomized into a fine spray of molten  
10 droplets directed onto a moving or stationary surface. The alloy components are selected and  
11 exclusively limited to nickel and chromium, respectively constituting between 48% and 52% by  
12 weight of the alloy while nitrogen is selected as the inert cover gas. The referred to atomization  
13 of the outflow stream of molten metal is effected by jets of the nitrogen gas pressurized for rapid  
14 surface deposit of the molten droplets having a very fine and uniform grain structure. A ductile  
15 matrix is thereby created in the deposited alloy with a fine dispersion of brittle phases in the  
16 formation of chromium nitrides resulting from mixing of the alloy components under cover of  
17 nitrogen as a crucial selection of the inert cover gas and exposure of the molten alloy outflow  
18 stream to such nitrogen gas pressurized for atomization purposes. Improvement in ductility, as  
19 well as a boost in strength of the ductile matrix was successfully achieved as a result of the  
20 selection of nitrogen as compared to argon as the inert cover gas.  
21  
22

#### 23 BRIEF DESCRIPTION OF DRAWING

24 A more complete appreciation of the invention and many of its attendant advantages will  
25 be readily appreciated as the same becomes better understood by reference to the following  
26 detailed description when considered in connection with the accompanying drawing wherein:  
27  
28

1 The drawing is a block diagram schematically illustrating the alloy forming process of the  
2 present invention.

### 3 DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

4 Referring now to the drawing, the method or process of producing an alloy composed  
5 exclusively of nickel and chromium in accordance with the present invention is diagrammed.  
6 Such method involves alloy content selection 10, pursuant to the present invention, in association  
7 with a spray metal casting or forming process 12 generally known in the art. As indicated in the  
8 block diagram, alloy content selection 10 involves use of between 48% and 52% by weight as the  
9 nickel content 14 and 52% to 48% by weight as the chromium content 16. Such alloy  
10 components initially undergo heating 18, within a receptacle such as a crucible, under cover of  
11 nitrogen selected as the inert cover gas in order to melt the nickel and chromium and allow an  
12 outflow 20 of a stream of molten alloy metal from the bottom of the crucible, as part of the  
13 diagrammed spray metal forming process 12. The nitrogen gas is also pressurized as denoted by  
14 reference numeral 22 and introduced as jets into the molten metal outflow 20 so as to atomize the  
15 outflow stream and break it up into a fine spray of molten metal droplets. Such molten droplets  
16 or particles undergo deposit 24, by direction onto a rotating or stationary mandrel surface for  
17 example, resulting in billets or shapes having a very fine and uniform grain structure.

18  
19  
20 The foregoing described method was utilized to deposit fifty (50) pounds of alloy of 50%  
21 by weight of nickel and 50% by weight of chromium within a minute. The alloy so produced had  
22 a yield strength of 145 ksi and tensile elongation of 25% or greater. The exposure to the nitrogen  
23 gas during heating of the alloy content and its atomization by such nitrogen gas during the spray  
24 metal forming process 12 created a high strength ductile alloy matrix with a substantially eutectic  
25 and fine grain structure of 100 micrometers or less in average grain size as well as a uniform  
26  
27  
28

microstructure. Also because of the fine chromium nitrides formed by such exposure to the atomizing nitrogen gas, a boost in alloy strength occurred.

The alloy fabrication method hereinbefore described may be beneficial in the formation of any alloy that is normally brittle due to the presence of TCP phases, by virtue of the fine dispersion of such phases within the ductile matrix.

Obviously, other modifications and variations of the present invention may be possible in light of the foregoing teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

## CLAIMS

1 1. In a method of producing a ductile alloy having a base metal by casting a molten stream as  
2 a spray of droplets onto a surface; the improvement residing in: selecting a corrosion resisting  
3 material as a component of the alloy exclusively limited thereto with the base metal for deposit  
4 onto said surface; and utilizing nitrogen as a cover gas for mixing of said component with the  
5 base metal and for atomization of the molten stream to endow the ductile alloy with high strength  
6 upon said casting thereof onto the surface.

1 2. The method as defined in claim 1, wherein said base metal is nickel and the corrosion  
2 resisting material is chromium.

1 3. In a method of producing an alloy with improved strength exclusively formed from nickel  
2 and chromium mixed under cover of an inert gas, by casting of a molten alloy stream onto a  
3 surface, the improvement residing in: selecting nitrogen as the inert gas; pressurizing said inert  
4 gas for atomization of the molten alloy stream into spray droplets; and directing jets of the  
5 pressurized inert gas into said molten alloy stream for effecting said atomization and deposit onto  
6 the surface.

1 4. In a method of producing an alloy from a base metal and a corrosion-resisting component  
2 respectively exhibiting high strength and high ductility properties, the improvement residing in:  
3 limiting the alloy exclusively to said base metal and the corrosion-resisting component; and  
4 forming the alloy by spray casting under exposure to nitrogen gas.

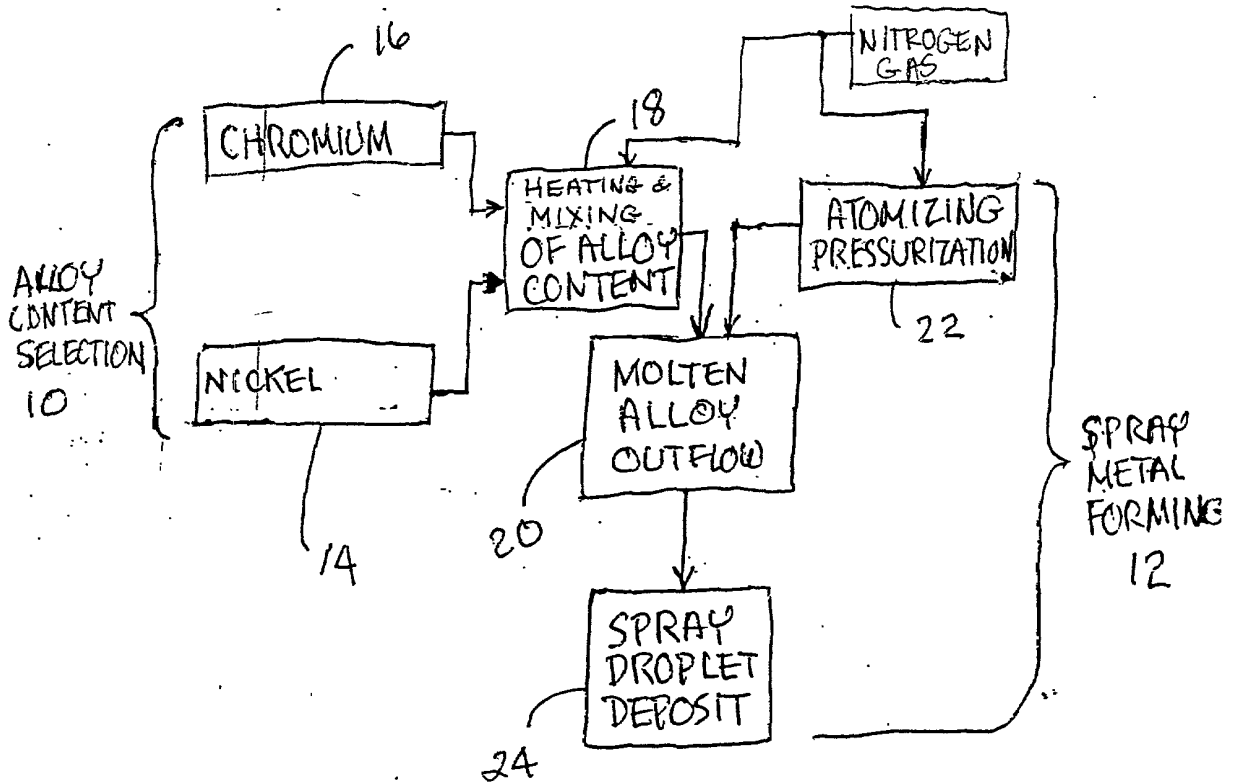
1 Navy Case No. 82,627

2 METHOD OF PRODUCING CORROSION RESISTANT METAL  
3 ALLOYS WITH IMPROVED STRENGTH AND DUCTILITY

4  
5 ABSTRACT OF THE DISCLOSURE

6 Nickel and chromium as the exclusive components of an alloy is formed by mixing under  
7 cover of nitrogen gas and spray casting thereof wherein a molten outflow stream of such alloy  
8 components is atomized by exposure to jets of the nitrogen gas after pressurization, resulting in  
9 formation of molten alloy metal droplets deposited on to a surface.  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28

METHOD OF PRODUCING CORROSION RESISTANT METAL  
ALLOYS WITH IMPROVED STRENGTH AND DUCTILITY





# DECLARATION AND POWER OF ATTORNEY IN COPENDING APPLICATION CONTAINING ADDITIONAL SUBJECT MATTER

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

That I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural names are listed below) of the invention entitled: **METHOD OF PRODUCING CORROSION RESISTANT METAL ALLOYS WITH IMPROVED STRENGTH AND DUCTILITY**

which is described and claimed in the attached specification;

that this application in part discloses and claims subject matter disclosed in my earlier filed pending application Serial No. 09/233,907, filed Jan. 21, 1999;

that I have reviewed and understand the contents of the specification, including the claims, as amended by any amendment specifically referred to in the oath or declaration;

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56;

that I acknowledge my duty to disclose information of which I am aware which is material to the examination of this application including information which occurred between the filing dates of the aforesaid earlier application and this application; that as to the subject matter of this application which is common to said earlier application, I do not know and do not believe that the same was ever known or used in the United States of America before my or our invention thereof or patented or described in any printed publication in any country before my or our invention thereof, or more than one year prior to said earlier application, or in public use or on sale in the United States of America more than one year prior to said earlier application;

that the common subject matter has not been patented or made the subject of an inventor's certificate issued before the date of said earlier application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to said earlier application; and

as to applications for patents or inventor's certificate on the common subject matter filed in any country foreign to the United States of America, prior to said earlier application by me or my legal representatives or assigns

☒ no such application have been filed, or

☐ such applications have been filed as follows:

## EARLIEST FOREIGN APPLICATION(S), IF ANY, FILED WITHIN 12 MONTHS PRIOR TO SAID EARLIER APPLICATION

COUNTRY	APPLICATION NO.	DATE OF FILING (DAY, MO., YR)	DATE OF ISSUE (DAY, MO., YR)	PRIORITY CLAIMED UNDER 35 U.S.C. 119 YES NO
---------	-----------------	----------------------------------	---------------------------------	---

## ALL FOREIGN APPLICATIONS, IF ANY, FILED MORE THAN 12 MONTHS PRIOR TO SAID EARLIER APPLICATION

COUNTRY	APPLICATION NO.	DATE OF FILING (DAY, MO., YR)	DATE OF ISSUE (DAY, MO., YR)
---------	-----------------	----------------------------------	---------------------------------

that as to the subject matter of this application which is not common to said earlier application, I do not know and do not believe that the same was ever known or used in the United States of America before my or our invention thereof or patented or described in any printed publication in any country before my or our invention thereof, or more than one year to this application, or in public use or on sale in the United States of America more than one year prior to this application;

that said non-common subject matter has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application; and as to applications for patents or inventor's certificate on the invention filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns,

☒ no such application have been filed or

☐ such applications have been filed as follows:

## EARLIEST FOREIGN APPLICATION(S), IF ANY, FILED WITHIN 12 MONTHS PRIOR TO SAID EARLIER APPLICATION

COUNTRY	APPLICATION NO.	DATE OF FILING (DAY, MO., YR)	DATE OF ISSUE (DAY, MO., YR)	PRIORITY CLAIMED UNDER 35 U.S.C. 119 YES NO
---------	-----------------	----------------------------------	---------------------------------	---

## ALL FOREIGN APPLICATIONS, IF ANY, FILED MORE THAN 12 MONTHS PRIOR TO SAID EARLIER APPLICATION

COUNTRY	APPLICATION NO.	DATE OF FILING (DAY, MO., YR)	DATE OF ISSUE (DAY, MO., YR)
---------	-----------------	----------------------------------	---------------------------------

I hereby claim the benefit under Title 35, United States Code §119(e) of any United States provisional application(s).

I hereby claim the benefit, under Title 35, United States Code, §120, of any United States application(s) or 365(c) of any PCT international application designating the United States of America and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the filing date of this application.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number), and hereby certify that the Government of the United States has the irrevocable right to prosecute this application:

**John L. Forrest, Jr., Reg. No. 29,378; Jacob Shuster, Reg. No. 19,660; Howard Kaiser, Reg. No. 31,381;**

SEND CORRESPONDENCE TO:	Office of Counsel Code 004 Naval Surface Warfare Center Carderock Division 9500 MacArthur Boulevard West Bethesda, MD 20817-5700	Direct Telephone Calls to:  Jacob Shuster (301) 227-1835
-------------------------	--	---

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of first inventor LOUIS F. APRIGLIANO

Inventor's signature *Louis Aprigliano* Date 9/5/00  
Residence 11 Canal Road, Berlin, Maryland 21811  
Citizenship U.S.A.  
Post Office Address 11 Canal Road, Berlin, Maryland 21811

Full name of second inventor LESLIE K. KOHLER

Inventor's signature *Leslie K Kohler* Date 9/5/00  
Residence 19036 Festival Drive, Boyds, Maryland 20841  
Citizenship U.S.A.  
Post Office Address 19036 Festival Drive, Boyds, Maryland 20841

Full name of third inventor \_\_\_\_\_

Inventor's signature \_\_\_\_\_ Date \_\_\_\_\_  
Residence \_\_\_\_\_  
Citizenship \_\_\_\_\_  
Post Office Address \_\_\_\_\_

Full name of fourth inventor \_\_\_\_\_

Inventor's signature \_\_\_\_\_ Date \_\_\_\_\_  
Residence \_\_\_\_\_  
Citizenship \_\_\_\_\_  
Post Office Address \_\_\_\_\_